Appendix M
Malathion Mosquito Adulticide Use

The malathion mosquito adulticide use pattern has been treated as an additional use pattern in a wide-area generic group in the main body of this report. EPA has previously conducted ecological risk assessments for mosquito adulticide uses of malathion (U.S. EPA 2007, 2009). In addition, the most recent biological evaluations (BE) (EPA, 2016a) examined the potential risks to listed species and critical habitat from adulticide use. However, the EPA assessments and malathion BE do not properly characterize the geographic extent of the use pattern, fate and behavior of malathion, potential environmental concentrations, or the potential for effects and ultimately risk. Therefore, risk has been significantly overstated for mosquito adulticide uses by the EPA assessments.

This appendix describes the approach taken to characterize potential exposure of listed species and the critical habitat on which they depend to the mosquito adulticide uses of malathion.

Adulticide Use

Application of the malathion adulticide is performed by certified applicators, using very specialized equipment. Mosquito adulticide applications are typically made by dedicated Mosquito Abatement or Control Districts (e.g. Benton County, WA - Mosquito Control District) and other state or local departments of public health. Mosquito Control Districts are local government entities established to protect the public from disease and nuisance associated with mosquitoes within specific boundaries. Applications are based on monitoring of mosquito populations, complaint calls, or may arise from an emergency situation (e.g., hurricane), or public health threat (e.g. Zika virus/malaria).

Spatial Extent of Use[4]

To characterize the use and geographic scope of malathion adulticide in the contiguous United States, data were summarized from four sources. The first was a survey conducted by Angela Beehler of the Benton County WA Mosquito Control District, for the American Mosquito Control Association (AMCA). The second was a survey of sales and distributors conducted by Cheminova Inc./FMC. The third was from publically available usage information from Florida, and the fourth was from publically available usage information from California. Each of these four datasets are described below.

The usage information from the AMCA is based on a series of surveys that covered the United States (Angela Beehler, personal communication 2015)(Figure M-1). There are 1060 U.S. members of the AMCA, and they were asked if they use malathion, and if so, how many applications they make per year (Table M-1). This list of potential users includes organized mosquito control districts that did not answer the email survey, but that would be capable of making mosquito adulticide applications. Figure M-1 shows the spatial extent of the members

[4] Portions of this section (Spatial Extent of Use) was originally prepared by Compliance Services International (CSI) with modification by Intrinsik Environmental Sciences Inc.

who responded to the survey (provided by Angela Beehler, Benton, WA, MCD pers. comm. e-mail: June 1, 2016).

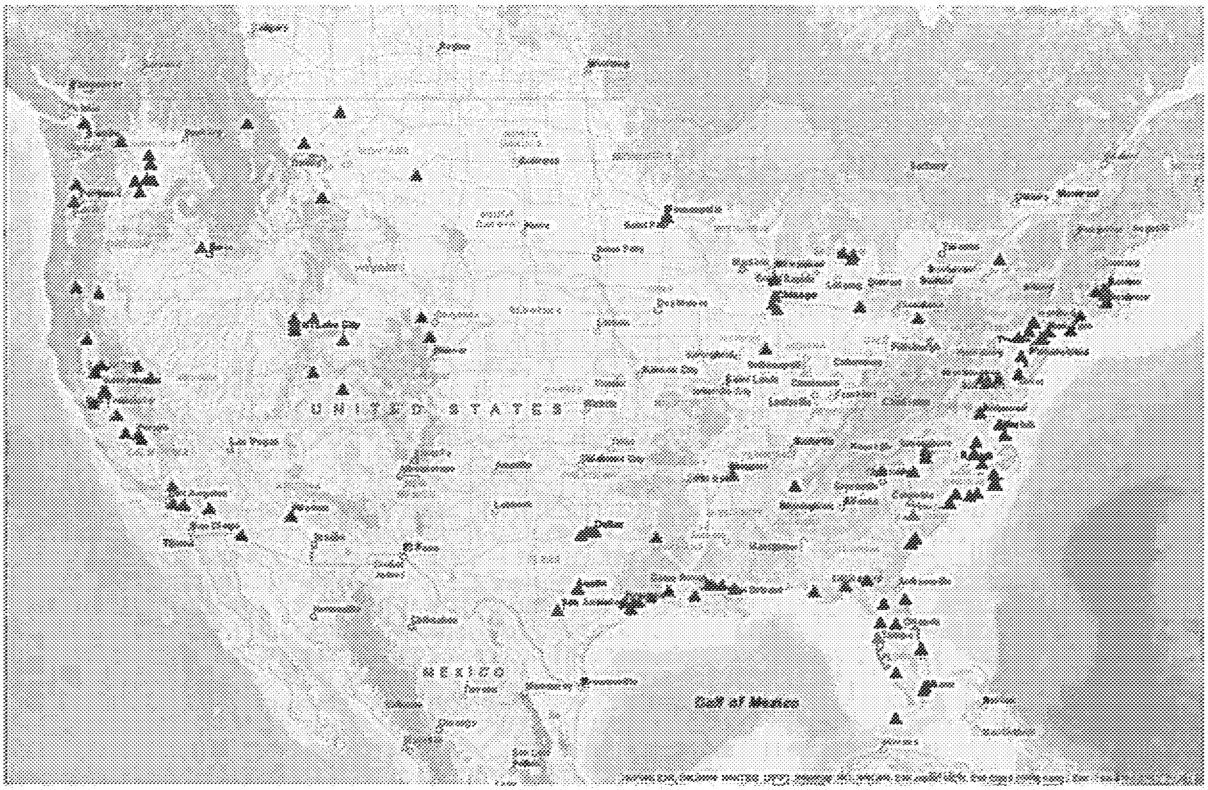

Figure M-1 Spatial extent of AMCA members surveyed in the conterminous US

Only a small number of the responding AMCA members reported using malathion in their mosquito control programs. These members are spatially represented in Figure M-2 (provided by Angela Beehler, Benton, WA, MCD pers. comm. e-mail: June 1, 2016). AMCA members who reported use of malathion also responded to the survey question "On average, how often do you use these products in the areas noted". For malathion, applications ranged from 1 to a maximum of 10 per year (Table M-1). In some cases, members reported that malathion was used in resistance management programs and thus it may be rotated with other products (e.g. pyrethroids) on occasion.

Table M-1 AMCA Survey Responses to Number of Malathion Applications per Year

	Number of Reported Malathion Applications Per Year					
	1-2	***3-4***	***5-6***	***7-8***	***9-10***	***Total***
Number of Districts	6	6	2	2	10	26
					Range	1 – 10
					Mean	5.2

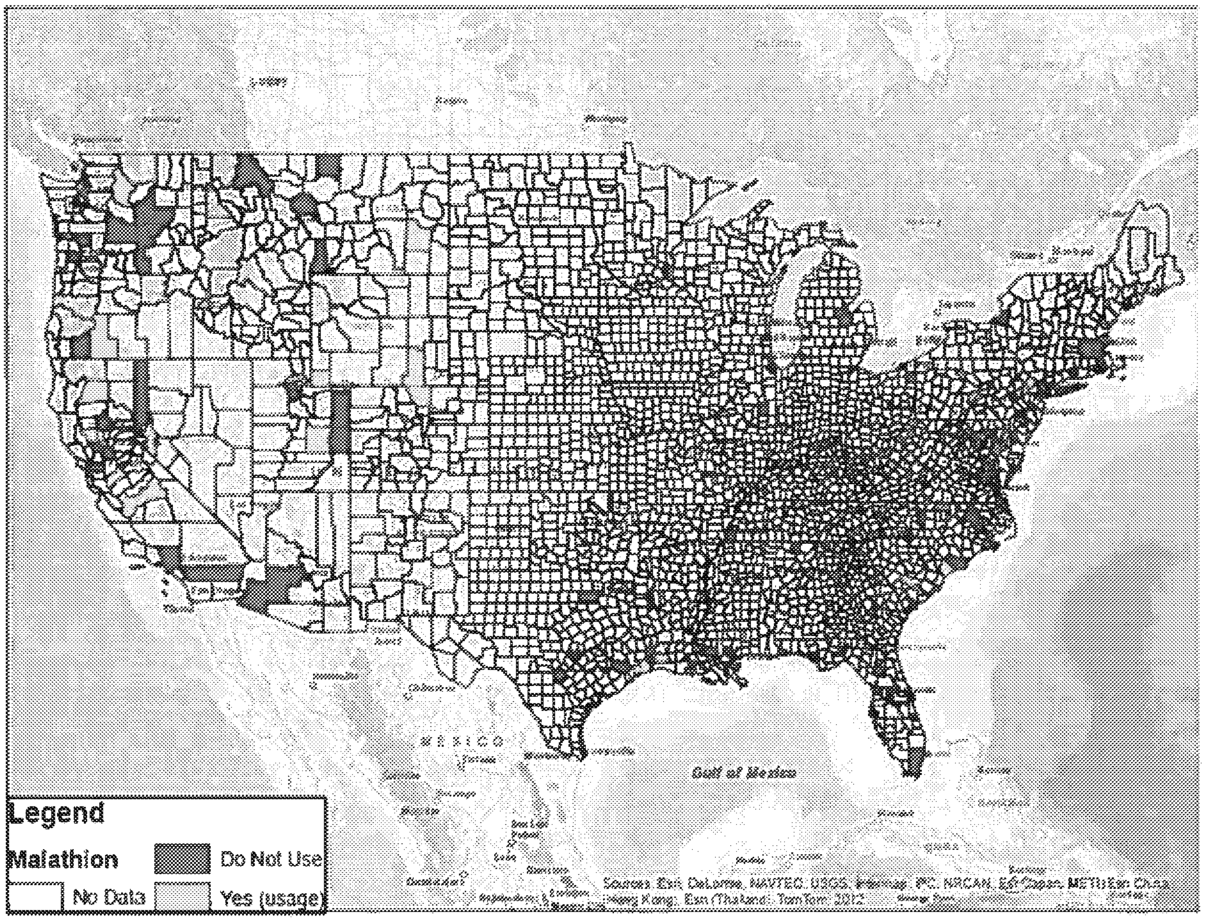

Figure M-2 AMCA survey responses specific to malathion use in the conterminous US

To supplement the AMCA association list, entities that reported use in the California and Florida pesticide databases were added. Then, based on information from Cheminova, a list of entities that purchased malathion in the last three years was obtained. Finally, regional and state vector control associations were asked to provide their member lists and malathion users. It is believed that these various data sources identified as using malathion mosquito adulticide provide the best available information on the coverage of the entities that have recently applied malathion as a ULV mosquito adulticide in the contiguous 48 states. The spatial resolution of the data is at the county level which is a coarse resolution and can be considered conservative. These data have been provided to the EPA.

To obtain malathion adulticide sales data, Cheminova/FMC tabulated all sales locations of its mosquito adulticide product, for Cheminova/FMC and its major distributor, for the years 2011 to 2014. These sales locations were either assigned to states and counties directly, or assigned to cities or ULV applicators. The complete dataset will be provided to EPA under separate cover as detailed sales information is claimed as confidential business information. For the purposes of public dissemination, the results are provided herein with resolution at the county level (Table M-2). Key points derived from these data are: (a) Scope of use -- although mosquitoes are widely distributed throughout the contiguous 48 states, actual applications for adult mosquito control have been made in only 159 counties in less than half of the states; (b) Volume of use -- malathion usage has dropped considerably since 2004. The relatively restricted geographic extent of use is a direct result of the fact that most ultra-low volume applications to control adult mosquitoes are made by Mosquito Abatement Districts or other local, state, or federal entities. Malathion adulticide use has decreased over the last few decades due to increasing preference for pyrethroids. However, because of the limited adulticide toolbox and because of growing resistance to the pyrethroids, OP use including malathion is expected to remain an important tool for resistance management.

Table M-2 Cheminova sales data[a] by county for 2011 to 2014 (Cheminova A/S)

Usage by State/County	*2011 (Oct - Dec)*	*2012*	*2013*	*2014 (YTD)*
TEXAS				
Austin County				x
Brazoria County			x	x
Broward County		x		
Calhoun County		x		
Chambers County	x	x	x	x
Galveston County		x	x	x
Harris County	x	x	x	x
Jefferson County	x	x	x	x
Orange County	x	x	x	x
LOUISIANA				
Calcasieu Parish			x	x
Jefferson Davis Parish		x	x	
FLORIDA				
Dade County	x	x	x	x
Indian River County		x		
Manatee County				x
Orange County		x	x	x
Pasco County			x	x
MISSISSIPPI				
Rankin County			x	x
Washington County		x	x	x
SOUTH CAROLINA				
Charleston County		x	x	x
Georgetown County			x	
Horry County		x	x	x
UTAH				
Salt Lake County		x	x	x
NEBRASKA				

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Table M-2 Cheminova sales data[a] by county for 2011 to 2014 (Cheminova A/S)

Usage by State/County	*2011 (Oct - Dec)*	*2012*	*2013*	*2014 (YTD)*
Wayne County				x
CALIFORNIA				
Stanislaus County				x
COLORADO				
Mesa County			x	
Moffat County			x	
Rio Blanco County				x
WYOMING				
Laramie County		x		x
NEW MEXICO				
San Juan County			x	
GEORGIA				
Lee County			x	

[a] Malathion adulticide is also sold from other minor suppliers and are not captured in Cheminova's sales data.

In addition to these broad county level tabulations of potential mosquito adulticide use sites, data were also obtained for the last 10 years from two states, California and Florida. The purpose of this exercise was to attempt to gauge the use rates, numbers of applications, and application intervals of ULV mosquito adulticide applications for these states, if possible.

Florida data were obtained from the website: http://www.freshfromflorida.com/Divisions-Offices/Agricultural-Environmental-Services/Consumer-Resources/Mosquito-Control/Reports

The dataset covers the years 2003 to 2014. Florida mosquito control data are summarized by active ingredient and county. Gallons of product, pounds of active ingredient, and acres treated are generally available for each county-year combination. Application methods are broken out by aerial and ground. Unfortunately, this Florida database does not provide the timing of applications, the number of applications, or the interval between applications. To estimate the intensity of usage in a particular county, the total county acreages were obtained, and then the total number of acres treated by air or ground were divided by the county acreage. This measure provides a crude estimate of the intensity of air or ground applications in each county.

The California data cover the years 2004 to 2013, and were obtained from the website: http://calpip.cdpr.ca.gov/main.cfm

Only data for non-agricultural applications were summarized. There is a category called Public Health Applications that relates most closely to the ULV mosquito adulticide uses. Data were obtained by county for each year. Timing of applications was included in the database. However, unfortunately, there were several pieces of missing data, including whether the application was made by air or ground and the application rate per acre. As had been done for the Florida data, county acreages were obtained. To estimate the number of acres that could be treated, the total pounds of malathion applied was divided by the maximum ground application rate. This estimated number of acres treated was then divided by the total acreage in the county to arrive at an index of use intensity for that county.

The four datasets were combined to generate a list of counties where ULV malathion mosquito adulticide applications have been made. To ensure that the potential for drift was taken into account, all counties adjacent to the counties where malathion ULV applications were reported to have been made were also included. The results of this tabulation are shown in Figure M-3. Based on the best available data available, ULV malathion applications have been made in 159 counties, and there are 514 adjacent counties for a total of 573 counties with potential for exposure.

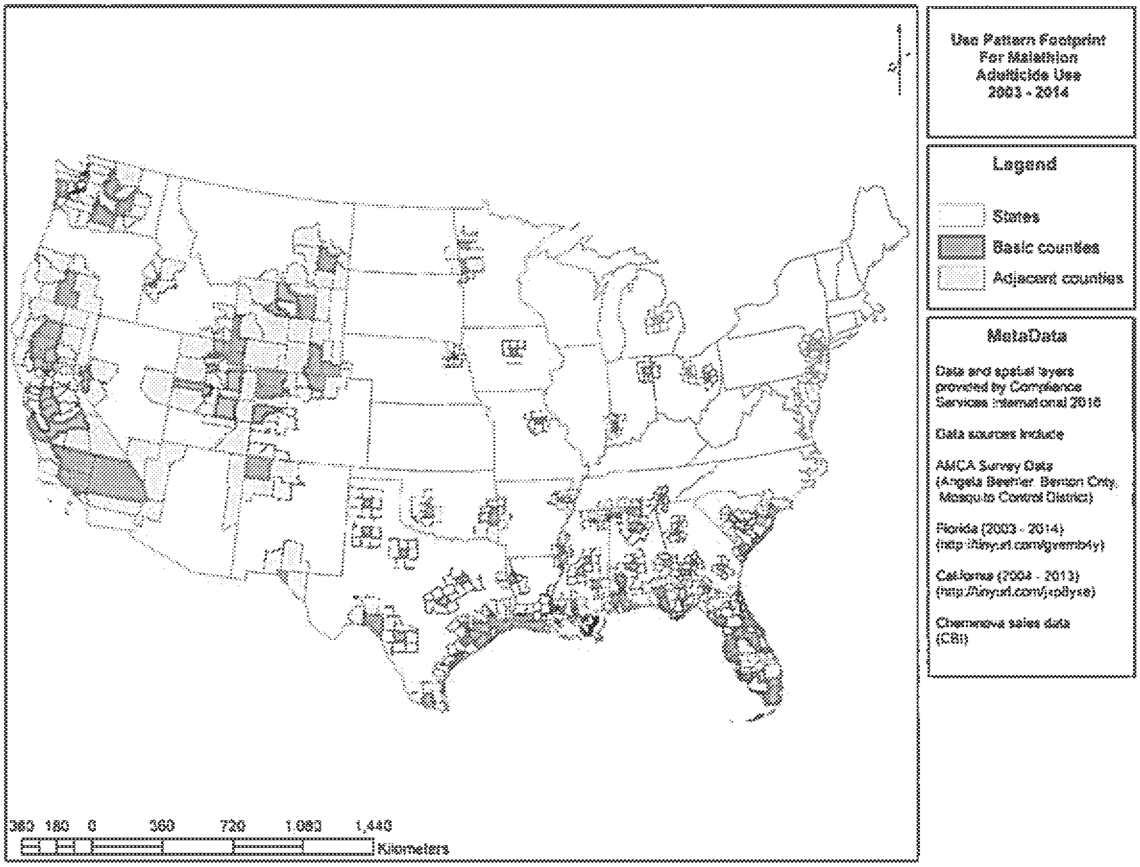


Figure M-3 Best available commercial use pattern footprint for malathion adulticide use (based on data covering 2003 - 2014)

In the Agencies BE for malathion (EPA, 2016a) (Chapter 4 and Appendix 4-5) the Agency suggests, but does not clearly state, that malathion adulticide use has the potential to occur across the entire spatial extent of the US including Alaska, Hawaii, and the US territories. This is the base assumption used in the BE (EPA, 2016a) with respect to the spatial extent of malathion adulticide use. This assumption is likely based on the fact that the malathion adulticide label does not place restrictions on where or when the adulticide may be used. The label is deliberately designed that way to allow for the public health managers maximum flexibility to respond to public health threats (e.g., Zika virus, malaria etc). On federal public lands, the decision to use adulticides would be made based on local policies for land management. We are aware of an effort by FWS to finalize a national policy for use of pesticides (including mosquito adulticides and larvicides) on federal lands. State lands have varying policies in place. Thus, there are restrictions on pesticide use on public lands and readily available commercial data that EPA has not attempted to collect and apply to characterize the use footprint for adulticides.

Based on the best available commercial data, the analysis presented in this section, as summarized in Figure M-3, clearly indicate the assumption of use across the entire spatial extent of the United States is incorrect. The spatial area identified is considerably smaller than the area considered in the malathion BE (EPA, 2016a). Therefore, the number of species (and critical habitat) that may potentially be exposed to malathion is considerably fewer than *all* listed species and their critical habitat as stated in the malathion BE (EPA, 2016a). This will be explored further in the following sections. The *Endangered Species Act* (1973) is silent on accounting for factors that in future may expand the action area, specifically related to the federal action being evaluated (in this case re-registration of a pesticide under FIFRA). Cumulative effects analyses may account for potential other activities *unrelated to the federal action* (e.g. State, municipal, private activities) (FWS/NMFS, 1998). Thus, consideration of the potential for the spatial expansion of adulticide use beyond what the best scientific and commercial data indicates during the evaluation of the federal action under the ESA is unwarranted. EPA's own organophosphate cumulative analysis indicated that cumulative risk from adulticides was anticipated to be a minor issue albeit for human health (EPA, 2002)

To protect public health from vectored diseases, adulticide applications need to be part of the toolbox available to public health agencies and these agencies need the flexibility to use the adulticides when and where needed in order to protect public health. While needed flexibility may lead EPA to conclude that the entire U.S. is a potential use area for an adulticide, this conclusion is not a realistic characterization of actual adulticide use in the U.S. In fact, adulticides are used in relatively limited geographic locations in the US. The spatial data on malathion adulticide use represents the best available scientific and commercial data. Similar data are likely available for other currently-registered adulticides, so the current use footprint can be defined. During the 15 year period between registration reviews, actual use of any single adulticide may expand or contract based on federal and local policies, resistance management needs, and to address public health threats for which the mosquito acts as a vector (e.g., West Nile virus, dengue, encephalitis, Chikungunya, Zika virus). However, it is highly unlikely that the use area for adulticides will expand dramatically over the next 15 years.

There is also a temporal component to the use of adulticides that has not been captured by EPA in the BE. While there may be active mosquito populations throughout the year in a few extreme southern parts of the US, other parts of the country may only have active mosquito seasons for 1 or 2 months each year. The temporal use also includes resistance management efforts of local mosquito control districts. For example, many districts rely on pyrethroids as their primary tool to control adult and larval mosquitoes. To offset growing resistance to pyrethroids, these districts may rotate in an OP once or twice per spray season, or alternate the use of pyrethroids and OPs from year to year.

Finally, adulticide use on public lands may also be restricted based on state and local land use policies. For example, managers of state or federal-owned lands make decisions on a case-by-case basis whether the allow mosquito control (either adulticide or larvicide), what products may be used and under what conditions. There is also a federal policy in development on the use of pesticides on federal lands that, when finalized this year, will impact how and when mosquitocides may be used. EPA has not collected this information and without it, EPA cannot accurately characterize how any mosquitocide is being used on public lands. In addition, on public lands, managers must submit a biological assessment prepared pursuant to ESA Section 7(a)(2) to evaluate the potential effects of mosquito control activities to listed species under the jurisdiction of the Services (e.g., USACE, 2014)

The spatial data on malathion adulticide use described herein represent the best available scientific and commercial data currently available, spatially characterizing the application of malathion adulticide throughout the U.S. This is equivalent to the best scientific and commercially available data to characterize crop footprints (e.g. Crop Data Layer (CDL), AgCensus data etc) for individual crops. The review period for pesticides is every 15 years under the *Food Quality Protection Act* (FQPA). Thus, spatial changes in use patterns such as adulticide application will be re-evaluated every 15 years and changes will be captured at that point. **No other use pattern being evaluated by the Agency is treated in the same way as the adulticides.** Changes in commodity production (e.g. corn for ethanol) are accounted for every 15 years using the best available data (e.g., CDL) and other data (e.g. AgCensus) to capture changes to crop use patterns over time (e.g., use of the last 5 – 10 years of the CDL to account for changes in the crop footprint).

The data in this section therefore, represent the best available characterization of the malathion adulticide use pattern for the purposes of this review under the ESA and will be applied in the assessment.

Adulticide Spray Drift

Malathion adulticide applications are intended to drift to maximize the amount of time that adult mosquitoes will contact the droplets in flight and subsequently be killed. Weidhaus et al. (1970) calculated that a minimum lethal dose of malathion to kill a single mosquito is contained in a 25 µm droplet. Haile et al. (1982) estimated a relationship between mosquito mortality and droplet size. The optimal droplet size from the relationship was calculated to be 10 – 15 µm. Thus, to obtain optimal efficacy for mosquito control, nozzles used in ULV applications of malathion typically have volume median diameters (i.e., VMDs) less than 100 µm, and are angled at 45°, both of which help maximize the time that malathion droplets linger in the air (Mickle et al., 2005; Schleier et al. 2012). In turn, this has the effect of maximizing the potential for drift and thereby minimizing the total quantity of sprayed material that will deposit in any one area. By design, the majority of the malathion sprayed in an agricultural setting will deposit onto the sprayed field. Mosquito control applications are designed to drift. Adulticide clouds have a very low settling velocity and transport characteristics that are similar to aerisols (Schleier et al. 2012). This is the opposite of malathion products intended for crop use where malathion is deposited in close proximity to the application equipment. Because of the unique characteristics of adulticide clouds, the standard regulatory spray drift models (AGDISP and AgDRIFT) are generally not well suited for use in modeling adulticide applications (Schleier et al. 2012).

Johnson (2014) conducted a review of available field studies (e.g. Mickle et al. 2005; Moore et al. (1993); Tietze et al. (1994, 1996); Knepper et al. 1996) and information on deposition of malathion mosquito adulticide applications in support of a request for information from the Canadian Pest Management Regulatory Agency (PMRA). Of particular interest was a study by Mickle (2005) that examined deposition of Fyfanon ULV (96.5%) malathion from ground and aerial applications. Mickle (2005) conducted field trials in Florida to compare deposition of Fyfanon ULV (96.5%) malathion from ground and aerial applications. For ground applications, a Clarke Grizzly nozzle was mounted 1.85 m above the ground and angled at 45 degrees. The chemical was injected at 6 psi and dispersed using a blower. The flow of chemical was dependent on the speed of the spray truck, with the intent to deliver 60.8 g a.i./ha. For aerial applications, nozzles mounted on the application plane were set to deliver 8.18 L/min flow at 1520 psi. The rate of application was 260 g a.i./ha over the same spray line width. Spray height using the aerial method was set to be 60 m. The study site for ground spray was a vacated sod field with 500 m of upwind fetch. Ground samplers were placed every 10 m from the spray line to 500 m downwind, with an impinger placed at every second sample site to measure drop density and size of the cloud. The study site for the aerial trials took place at a different location. Samplers were placed every 100 m along the roadway, up to 5000 m from the flight line. Impingers were placed every 200 m to determine droplet size and density. For ground applications, peak deposit levels were higher in lower wind conditions, up to 20 gm/ha. Drop densities were greatest 50-150 m from the application site and ranged from 300-500 drops/cm^2. For both aerial and ground applications, four passes were made for each trial, occurring in opposite directions along a 10 km spray line. An application rate that was four times greater than permitted by the label was also used to ensure the chemical would reach the 5000 m samplers. Results suggest that up to 50% of the spray was deposited within the 500 m downwind sample area. Deposition from aerial application ranged from 6-20 g/ha, similar to that for ground applications, with maximum deposit occurring within 500 -1000 m of the flight line. Peak drop density occurred 1 km downwind from the deposit peak. Additionally, drop size was found to decrease with distance away from the flight line and up to 55% of the total emitted malathion was recovered within 5 km. The vast majority of recovered chemical collected within the first 2000 m downwind of application for all aerial trials. It was determined that ground applications produced greater drop densities than did aerial applications when normalizing for malathion released per unit length of spray line.

One additional field study was reviewed here. Schleier et al. (2012) conducted three ground-based ULV field trials, one in each of Elk Grove, CA, Bozeman, MO, and Baton Rouge, LA. The sites chosen had little vegetative structure (i.e. low interception) and a flat topography. The sites were 200 m long and horizontal drift collectors were placed 25 m left and right of center or the plot. Applications were initiated in the evenings (no earlier that 18:00) with most applications later to maximize the number of adult mosquitoes present. Deposition was collected using ground-level petri dishes and a fluorescent tracer was used to track the presence of the droplets using a fluorometer. The data points collected from the three field trials were combined (N=1067) and used for statistical analysis. Regression analysis of the data yielded a relationship between numerous variables (e.g., wind speed, application rate, flow rate, density VMD, and others). The model describing these relationships was recommended for use in evaluating deposition and potentially as a tool for regulatory decision making. However, subsequently the findings by Schleier et al. (2012) have come under scrutiny. Teske et al. (2015) reviewed the Schleier et al. (2012) paper that summarized the workings of a regression model used to predict dispersion of ground-based ultra-low volume (ULV) pesticide applications used for mosquito control. The MULV-Disp model was developed as an improvement to the widely-used AgDISP model for ULV application. The MULV-Disp was developed from field tests that evaluated deposition of seven ULV formulations up to 180 m downwind of application. Pesticides were applied from a spray gun mounted on a pickup truck, which is typical for application of mosquito adulticides, to flat land with little vegetation. Teske et al. (2015) stated that application to flat, non-vegetated surfaces was a model flaw, as it reduced applicability for most application scenarios and decreased deposition. Teske et al. (2015) was most critical of the data collection methods used by Schleier et al. (2012) for meteorological data. The Hobo Micro Station Data Logger has very low accuracies and high data collection thresholds (Teske et al., 2015). Therefore, data like wind speed, which was reported as lower than the stall speed for the data capturing device, were likely incorrect and skewed the results (Teske et al., 2015).

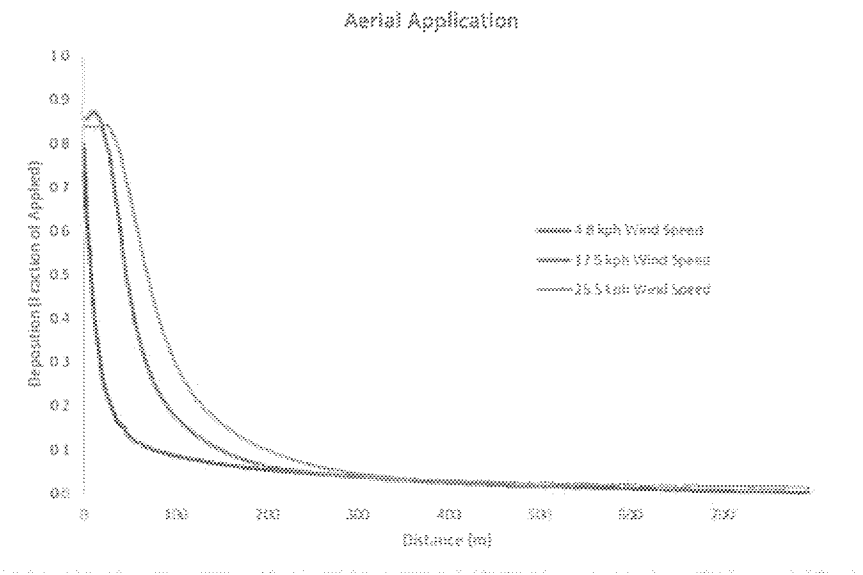
Teske et al., (2015) was also highly critical of the collection methods for pesticide deposition used by Schleier et al. (2012). In fact, Schleier et al. (2012) used flat, glass Petri dishes for collection, which reportedly have less than 20% collection accuracy when compared to rough dishes (Thistle et al., 2009; Teske et al., 2015). Compounding matters, Schleier et al. (2012) failed to correct for collection efficiency, which contributes a significant amount of uncertainty to calculations. Schleier et al. (2012) measured an average deposition of 10.4% within the 180 m field. Considering the application of aerosols, a deposition field of 180 m is extremely short (Teske et al., 2012). Additionally, the 90% of mass that is unaccounted for may have been the result of analytical errors, lack of correction for collection efficiency, incorrect calculations of wind speed and other meteorological conditions, or any number of other reasons. Basing all calculations on a deposition of 10.4% is highly uncertain.

Teske et al. (2015) also found a number of issues with regards to the regression model used in MULV-Disp. For example, when applied from a truck with a gun pointed upward at 45°, one would expect minimal deposition adjacent to the truck, with increasing deposition at increasing distance then decreasing deposition once the peak has been reached (Teske et al., 2015; Mickle, 2005). Instead, the regression used in MULV-DISP has peak deposition at the point of release and decreasing deposition at increasing distance from the site of application.

In terms of model sensitivity, Teske et al. (2015) found that the MULV-Disp model incorrectly predicts deposition when the application rate is adjusted. For example, Schleier et al. (2012) showed a 59.5% decrease in deposition within 180 m of application when the application rate was increased, while in actual fact deposition should increase if the application rate is increased

(Teske et al., 2015). Furthermore, an increase in flow rate would increase the droplet size and in turn, increase deposition, but MULV-Disp predicts a decrease in deposition when flow rate is increased. Therefore, the model described in Schleier et al. (2012) was not used to estimate ground application of ULV malathion as an adulticide.

Johnson (2014) determined that the data generated by Mickle, et al. (2005) constitute the best available information to estimate deposited residues of malathion following aerial and ground ULV applications for mosquito control. Based on Mickle et al. (2005), deposited residues of malathion following aerial and ground ULV applications at 260 g ai/ha and 60.8 g ai/ha, respectively, can be estimated for risk assessment purposes in a few different ways. First, maximum average deposited residues were the same (approximately 0.070-0.075 μg/cm²), regardless of application method. Second, over the first 93 m (swath width) downwind from the spray line, average deposition is approximately 0.03 μg/cm² following ground applications and practically negligible following aerial applications. Third, based on integrated deposition, average deposited residues are approximately 0.028 μg/cm² across the 500 m downwind from a ground application and approximately 0.022 μg/cm² across the 5 km downwind from an aerial application. A protective yet representative exposure estimate would result when potential post-application residential exposures are estimated using one or all of the measured deposition values from Mickle et al. (2005). In addition, Mickle, et al. (2005) successfully parameterized the regulatory spray drift model AgDISP v8.13 to simulate ULV mosquito control application conditions. The input parameter values for equipment, application and nozzles are used to predict deposition for different application rates, conditions or chemicals malathion ULV mosquito control applications using AgDISP v8.27 in this assessment. The spray drift curve for both aerial and ground application from Mickle et al. (2005) is depicted in Figure M-4.



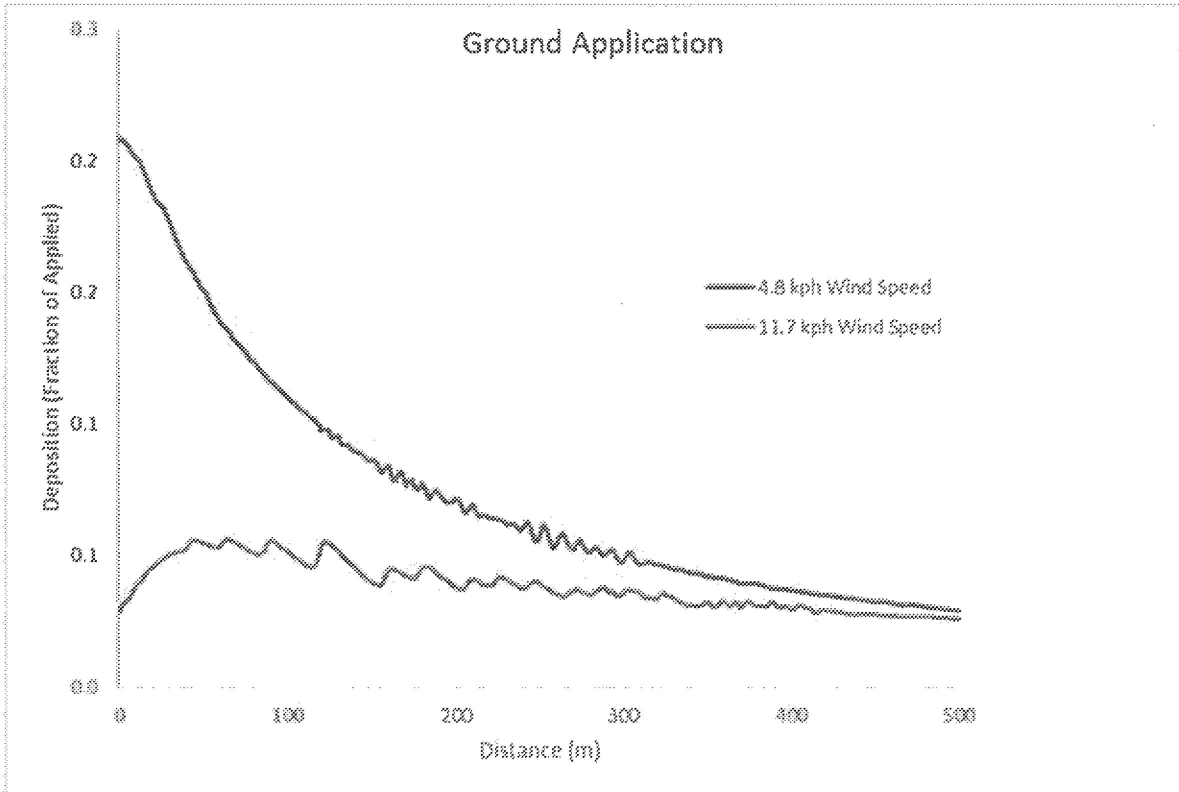


Figure M-4 Aerial and ground deposition spray drift curves from Mickle et al. (2005)

The Mickle et al (2005) spray drift curves were used in the terrestrial ESA assessment to evaluate potential exposure of plants and wildlife to mosquitocide spray.

Aquatic Modeling

For aquatic taxa, environmental exposure concentrations (EECs) were calculated for illustration purposes, for the three flowing and three static habitat bins as characterized in Table M-3. The EPA tool, Pesticide Water Calculator (PWCv1.5) was used to estimate EECs for the aquatic bins 2-7 for malathion adulticide applications. In these simulations, malathion was applied six times annually at a rate of 0.067 lbs ai/A per application applied three days apart. This represents a higher than average annual application frequency as captured in the AMCA survey of AMCA members (Table M-1)

Table C-3 Characteristics of aquatic habitat bins (EPA, 2016a)

Generic Habitat	*BIN#*	*Depth (m)*	*Width (m)*	*Length (m)*	*Flow (m^3/s)*	*Velocity (m/s)*
Low flow	2	0.1	2	Length of field	0.001 - 1	0.005
Medium flow	3	1	8	Length of field	1 - 100	0.14
High flow	4	2	40	Length of field	>100	1.4
Low volume	5	0.1	1	1	Static	Static
Medium volume	6	1	10	10	Static	Static
High volume	7	2	100	100	Static	Static
Nearshore intertidal	8	0.5	50	Length of field	-	-

Table C-3 Characteristics of aquatic habitat bins (EPA, 2016a)

Generic Habitat	*BIN#*	*Depth (m)*	*Width (m)*	*Length (m)*	*Flow (m^3/s)*	*Velocity (m/s)*
Nearshore subtidal	9	5	200	Length of field	-	-
Offshore marine	10	200	300	Length of field	-	-

The same application efficiency (29%) and aquatic bin specific drift fractions listed in BE Appendix 3-3 (Table B3-3.3)(EPA, 2016a) were used in the modeling. Runoff curve numbers were lowered so that no runoff was simulated. Adulticides are applied to remain in the air to maximize the potential for contact with flying mosquitoes. The Mickle et al. (2005) study described above indicated that deposition does occur slowly over fairly large distances depending upon wind speed (Figure M-4). The water half-life was set to 3.27 days, hydrolysis half-life of 6.21 days, benthic half-life of 7.64 days, and a K_{OC} of 151 L/kg.

The predicted aquatic EECs using PWCv1.5 are provided in Table M-4. One day EECs ranged from 0.00066 µg/L (Bin 4) to 8.82 µg/L (Bin 5). These EECs are used in the NESA to evaluate risks to aquatic organisms (or terrestrial organisms with an aquatic life-stage) in Step 1.

Table M-4 Aquatic EECs for malathion ULV adulticide application at the maximum applications rate (0.234 lb/A) and 6 applications with one day interval.

Bin#	*Generic Habitat*	*Drift Fraction**	*Depth (m)*	*Width (m)*	*Length (m)*	*Flow (m^3/s)*	*Water EECs (ppb)*				
							Peak	*1-Day*	*4-Day*	*21-day*	*6-Day*
2	Low flow	0.076	0.1	2	356.8	0.001	5.75	2.86	1.60	1.01	0.36
3	Moderate flow	0.072	1	8	356.8	1	0.54	0.018	0.0089	0.0051	0.0018
4	High flow	0.053	2	40	356.8	100	0.20	0.00066	0.00033	0.00019	0.000066
5	Low volume	0.077	0.1	1	1	0	10.10	8.82	7.27	5.54	2.12
6	Moderate flow	0.071	1	10	10	0	1.11	1.00	0.85	0.65	0.25
7	High volume	0.035	2	100	100	0	0.28	0.25	0.21	0.16	0.06

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Uncertainty

Spatial

- The AMCA member survey collected responses from 21% of the members surveyed. Therefore, there could be more malathion adulticide use across the U.S. than the AMCA survey results depict. However, the combined AMCA survey results, Florida and California dataset, and Cheminova sales data help to reduce this uncertainty source and combined these data represent the best currently available data.

Terrestrial Modeling

- Mickle et al. (2005) conducted five aerial and five ground spray tests in open field conditions. Thus, it is one of the most extensive, conservative drift studies available for ULV adulticide applications. All meteorological conditions were typical of standard operating conditions. The open field applications also minimized spray drift interception (by vegetation) and maximized drift distances. Therefore, the drift curves are considered conservative for use in the risk assessment. The presence of vegetation could alter estimates and thus there is uncertainty associated with topography.

- Mickle et al. (2005) optimized AGDISP to predict maximum deposits drift deposits that were equivalent to those measured in the field. By adjusting AGDISP to account for Mickle et al. (2005), it is possible to use AGDISP to model ULV adulticide application. There are uncertainties with this process including potential differences in results due to wind speeds, for example. This uncertainty is not expected to overly influence the risk assessment as multiple wind speeds were evaluated for both ground and aerial application in the Mickle et al. (2005) study.

Deposition

- In the terrestrial assessment, application efficiency was assumed to be 0.29 as per the approach used by EPA in the biological evaluation (EPA, 2016a). There is some uncertainty with respect to this value. However, it is highly unlikely that adulticide application efficiency would exceed 1 at any time given the equipment and delivery methods used. The US Forestry Service indicated that point deposition fractions could exceed 1 (EPA, 2016a – Appendix 3-3). This is true for crop ground applications at the edge of field when multiple swaths are considered. It is not true for mosquitocide applications where equipment is angled at 45° for ground applications and one swath. The application efficiency of 0.29 is considered a reasonable estimate for use in the evaluation of adulticide applications at screening. In a refined assessment this variable could be made into a distribution to capture uncertainty about the variable and its impact on exposure.

- Topography of the area in which an adulticide is sprayed as well as the method used (ULV or thermal fog aerosol) can have a significant impact on deposition and the effectiveness of the application (Britch et al. 2010). Therefore, rate of deposition may be an excellent variable to address with a distribution of rates in a probabilistic model in future assessments to capture uncertainty and its impact on exposure.

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